POLICY RESEARCH WORKING PAPER 1723

The Productivity Effects of Decentralized Reforms

An Analysis of the Chinese Industrial Reforms

Reform aimed at decentralizing ownership and control rights seems to work when it creates incentives for managers and employees to learn and to work hard — for example, by decentralizing the right to control wages, make production decisions, and appoint new managers.

Lixin Colin Xu

The World Bank
Policy Research Department
Finance and Private Sector Development Division
February 1997

Summary findings

The empirical literature on the effects of ownership has not distinguished between the effects of ownership and the effects of control. It has also generally ignored the dynamic effects of various ownership and control rights.

Using a rich set of panel data about changes in China's state-owned enterprises, Xu examines the static and dynamic effects of decentralizing ownership and control rights.

He finds that productivity and growth rates improved significantly when reform improved the incentives for managers and employees to learn and to work hard — for example, by decentralizing the rights to control wages, make production decisions, and appoint new managers.

Increasing profit-retention rates and adopting performance contracts — conventionally viewed as the most important reforms for China's state enterprises — did not improve productivity much.

Overall, decentralization accounted for at least 42 percent of productivity growth in Chinese state enterprises in the 1980s. Much of that gain came from improvements in the growth rate of productivity rather than in improved levels of productivity.

This paper — a product of the Finance and Private Sector Development Division, Policy Research Department — is part of a larger effort in the Department to understand the limits between the organization of a firm and economic performance. Copies of this paper are available free from the World Bank, 1818 H Street NW, Washington DC 20433-0001. Please contact Paulina Sintim-Aboagye, room N9-030, telephone 202-473-8526, fax 202-522-1155, internet address PSintimaboagye@worldbank.org . February 1997. (32 pages)

The Productivity Effects of Decentralized reforms:

An Analysis of the Chinese Industrial Reforms

Lixin Colin Xu[1]

[1]I am grateful to Honggao Cao, Bob Cull, Steve Herscovici, Joe Hotz, Gale Johnson, Yair Mundlak, Sherwin Rosen, and Robert Vishney for suggestions. Thanks also go to workshop participants at the University of Chicago, University of Toronto, UC-Davis, and the World Bank. The data set was kindly provided by Dr. Du Hai Yan. Financial support from the Prince Foundation, Asian Dissertation Writing Fellowship, and the University of Chicago are gratefully acknowledged.

I. INTRODUCTION

Economists agree that the ownership of a firm affects its productivity. The theory of the firm suggests that the productivity of a firm is affected by various ownership or control rights: cash flow rights, internal incentives, managerial incentives, and production decision rights (Holmtrom and Tirole, 1989). Subsumed within this literature may be the contract that firms sign with governments. Moreover, the recent surging literature on the relationship between firm-specific human capital and growth suggests that it may also be important to examine the dynamic effects of change in the organization of a firm (Lucas, 1988; Romer, 1986). The empirical literature on the relationship between ownership and productivity, however, has not caught up: it is almost exclusively of static nature, and the ownership variables are usually represented by dummy variables such as private (or state) ownership, collectives, etc (Boardman and Vining, 1989). An exception is Ehrlich et al. (1994): they analyze the dynamic effects of private versus state ownership, find that state ownership is associated with lower growth rates, and suggest that it is because private ownership facilitates the accumulation of firm-specific human capital.

This paper continues this direction by examining the effects of ownership on both productivity levels and growth rates. Controlling for specific features of ownership, I focus on the effects of decentralized control rights and cash flow rights on growth. In particular, I consider how changes in ownership and control rights affect both SOEs productivity levels and growth rates. Among these changes are appointing new managers, delegating production autonomy to managers, reducing the share of output under the government's plan, using performance contract and firm-level pay sensitivity, and allowing the managers to determine wages of employees. This rich description of ownership and control, seldom tried in the literature, is available for a panel data set of Chinese SOEs.

In the panel data set we observe the timing of each of the reforms. We can use the before-after changes in productivity and their trends to identify the level and growth effects of a reform. Sufficient cross-section and time-series variation arises because the Chinese government adopted a decentralized attitude toward reforms; as a result, each reform was implemented at different time, and firms in different provinces, cities, industries, or governed by different levels of government, could experience distinct timing for the same reforms.

A natural byproduct of this analysis is an examination of the reasons behind changes in productivity of Chinese SOEs. Though there is abundant literature studying this question, to the best of my knowledge, nobody has examined such a rich set of changes in ownership and control in China, and nobody has studied their dynamic effects.

The empirical analysis offers many insights into the relationship between ownership, control and productivity. We find that, when decentralized reforms improve the incentives of the managers and the employees to work hard and learn, productivity improves sizably: appointing new managers improved the productivity growth rate for county-governed and province-governed SOEs by roughly 6% annually; the delegation of production decisions improved productivity levels by 6.7%, and growth rates by 2.6%; the decentralization of wage determination rights improved productivity levels by 7.6%, and growth rates by 3.4%. The adoption of the Contract Responsibility System and the increase of profit retention rates, conventionally thought the most important of the Chinese SOE reforms, are found to be least effective. The findings are robust with respect to the choices of production function form and of deflators, the use of value added or the gross value of output as the outcome measure, and the endogeneity of some important variables. The findings confirm the notion that a decentralized reform is likely to work when it inspires incentives to work hard and learn.

II. THE DECENTRALIZED REFORMS

This research uses *A Survey of State Enterprises: 1980--1989*, a retrospective survey conducted by the Chinese Academy of Social Science in 1991.[2] The data set is a balanced panel design: no firms were dropped out during the 10 years.[3] Survey questionnaires were sent out by the provincial System Reform Commissions to 800 state enterprises. Valid responses from 769 firms, located in 21 cities in four provinces of China (Sichuan, Jiangsu, Jilin, and Shanxi), were received. The data set was not designed to be a random sample of the state enterprises: making up more than 70% of the sample, large firms were over-represented. The median firm of the sample had 931 employees.

The data set consists of two parts. Part one, intended to be completed by the accountant of the firm, contains quantitative tables with details of the firm's production inputs, outputs, internal incentives, wages, labor composition, and profit distributions between the government and the firm. Part two, to be completed by the manager, contains information on the firm's industry affiliation, age, and size; the contract terms of the manager; the relationship of the firm to the government; when the firm was granted the discretion to plan output levels and what to produce, whether the manager had the discretion to determine wages; the share of the firm's input from subsidized state sources, from the market, and from bartering with other firms, etc. It also has information about how value added was distributed, and how the decentralized reforms evolved over time.

During the 1980s, the Chinese government experimented with decentralizing SOEs to boost productivity. By the end of the decade, those state enterprises had a much different legal structure, and became much more, though not completely, market-oriented.[4]

Both the productivity level and input uses of firms changed over this period. The average labor productivity of the firms in the data set increased at 2.6% annually.

---

[2]This data set has been used by many other authors, including Groves et al. (1994, 95).
[3]In the 1980s the Chinese SOEs did not face a real threat of bankruptcy.
[4]See Johnson (1990), Tidrick et al. (1987), Perkins (1994), and Jefferson and Rawski (1994) for more thorough coverage of industrial reforms and the rural reforms of China.

Employment in firms grew much faster than capital stock. The employment of state enterprises increased at a rate of 3.5% per year, while the capital-labor ratio remained largely unchanged.

The management and property rights of state enterprises changed dramatically over the 1980s. At the beginning of the 1980s, both control and ownership belonged to the state: all profits were turned over to the state, and the entire investment fund, wage, and collective welfare expenditures were allocated by the state. The managers, therefore, did not have autonomy over production decisions and wage determination. State enterprises were largely managed by bureaucrats, and since there was no link between performance and reward, the employees and managers did not have incentives to improve.

Over the 1980s the Chinese government partially and gradually decentralized ownership and control rights. Setting the stage for these reforms, the government opened up the market: after SOEs had fulfilled their mandatory output quota delivered to the state, the government allowed them to sell their output to the market. Besides obtaining them at subsidized state prices, firms could also purchase inputs from the market.[5] Between 1980 and 89, the share of material inputs purchased through the market rose from 32% to 59%, and the share of output sold on the market went up from 49% to 60% (Dong 1992). At the meantime, SOEs faced increasing competition from the non-state sector: in 1980, collective and other non-state-owned industries accounted for 21% of gross value of industrial output; by 1991 this figure had risen to 47% (Perkins 1994). Opening the market and enhancing competition were necessary for other reforms to be effective. The next subsection describes the changing nature of reform during this increasingly competitive periods.

[5]It was called dual price system in China, where market and state prices coexist. The government limited the amount of subsidized inputs a SOE could obtain, beyond which the SOE had to resort to the market at higher prices. See Perkins (1994), Johnson (1990).

Trends in Reform

1. Decentralizing cash flow rights by increasing profit retention rates. The average marginal retention rate[6] rose from 11% in 1980, to 17% in 1984, and 27% in 1989. The variation across firms and over time was substantial. A firm could use the retained profit to invest, improve collective welfare (such as housing and firm-owned schools), or pay employees a bigger bonus. However, the manager could only use retained profits subject to many constraints such as a bonus cap, a very high progressive tax rate, or increasing dependency on self-financing for capital investment, for which the government was previously fully responsible. Note that the marginal retention rate at year t was set at the end of year $t-1$; as a result, it presents less of a problem in identification because it can be considered as pre-determined.

2. Autonomy of production decisions. At the beginning of the 1980s the government controlled most of the production plans of the state enterprises. Over the decade it gradually granted some firms more autonomy in production decisions, concentrating on six areas: value of output, physical quantity of output, choices of product, technology, production scheduling, and exports.[7] The proportion of autonomous firms increased from 7% in 1980 to 25% in 1984, 53% in 1987, and 67% in 1989. Another aspect of the autonomy of firms in production decisions was the decrease of the

[6]The marginal profit retention rate is the share of (profit minus base profit) that a SOE retains. The base profit amount was subject to a base profit retention rate, determined ex ante by the government (at the end of last year). In this paper, the base retention rate is treated as a lump sum transfer to a firm.

[7]These areas of production decisions were delegated around the same time, with the exception of production scheduling, which came earlier, and exports autonomy, which came later.

Table 1. Trends of the Decentralized Reforms in the 1980s

	80	*81*	*82*	*83*	*84*	*85*	*86*	*87*	*88*	*89*
Marginal retention rate	.11	.12	.11	.14	.17	.17	.19	.23	.26	.27
Autonomy of production decisions	.07	.08	.10	.14	.25	.35	.40	.53	.64	.67
Share of output under mandatory plan of the government	Not available				.64	.62	.60	.58	.57	.57
Share of firms with wage discretion	.01	.01	.01	.02	.05	.09	.12	.20	.32	.35
Share of firms under Contract Responsibility System	.00	.00	.00	.01	.02	.04	.08	.42	.83	.88
Ex ante firm-level pay sensitivity for firms under CRS	Too few observations				.51	.39	.41	.46	.43	.42
Share of firms with management turnover	.09	.01	.06	.10	.16	.14	.07	.15	.10	.09

Note. All numbers come from the author's computation based on *A Survey of State Enterprises: 1980-89.*

share of output under the government's mandatory plan,[8] which was reduced from 64% in 1984 to 57% in 1989 for the firms in our sample.

3. More discretion for managers of state enterprises to determine employees' wages. Traditionally the government set an employee's wage as an almost deterministic function of his or her age, education, location, tenure and gender, leaving managers with little leverage to induce employee effort. This was reinforced by the employment guarantee.[9] To give more discretionary power to managers of state enterprises, the Chinese government granted some firms *managerial wage discretion*,[10] controlling only the growth rate or aggregate amount of wages for the firm. The proportion of firms with the *managerial wage discretion* mainly increased in the latter 1980s: from 0.5% in 1980, to 5% in 1984, 20% in 1987, and 35% in 1989.

[8] A state enterprise's output fell into three categories: mandatory plan by the government, which was set up by the government and must be fulfilled, directive plan that was suggested by the government, and own plan which was under the discretions of the manager.

[9] Part of the reason was that the "fall-back position" for the fired employees would be quite unattractive: it was very difficult for the gurantee to find jobs outside the incumbent firm due to a rigid labor market; in addition, since the social security and welfare function were carried out by the state enterprises rather than the market or the state, the dismissed employees would lose much of their firm-specific benefits such as housing, tenure wage, pension plan if they left the incumbent firms.

[10] It is called a firm-specific wage scheme in the questionaire.

4. *Contract Responsibility System* (CRS) and linking wage increase with profit increase.[11] The counterpart to the Household Responsibility System of the Chinese agricultural reform,[12] CRS was probably intended to be the most dramatic reform for the state enterprises. Under a CRS contract, the manager had the legal right to operate the firm, and was granted some discretion to make decisions within the firm for an agreed duration, usually 3--4 years.[13] Typically, a CRS contract specified the distribution of value added between the state and the firm, the performance requirements such as the minimum annual expenditure on capital maintenance, the number of new products to be developed, the volume of output and its price to be delivered to the state, the dependence of CEO compensation on the performance of the firm, and the *ex ante* firm-level wage elasticity with respect to profit. Note that this aggregate pay sensitivity existed *only* when the firm was under the CRS.

Most firms adopted CRS only after 1986. There was virtually no firm with a CRS contract in 1980, only 2% of them in 1984, but 42% in 1987, and 88% in 1989.

5. Increasing management turnover. The share of firms with management turnover generally increased over the decade, especially in 1983-85 and 1987-1989. The increase, however, is by no means smooth: it was 9% and 6% in 1980 and 1982, then jumped to 16% and 14% in 1984 and 1985; it dropped to 7% in 1986, then increased to 15% in 1987, dropped again to 10% and 9% in 1988 and 1989.

III. HYPOTHESES OF THE EFFECTS OF DECENTRALIZATION

[11]All information about CRS is from *CRS in Practice*, complied by the Research Group for The Chinese Firm System Reform.

[12]Lin (1993), McMillan et al. (1987) attributed the unprecedented increase of farming productivity in China in the first half of the 1980s largely to the adoption of the household responsibility system.

[13]Usually, the contract for a firm implementing CRS was signed by the industrial bureau, which was a branch of government in charge of the industrial state enterprises, or some representatives of the firm, along with the manager--the winner among bidders for the contract. The winner of the bid was determined by a committee representing the government, and sometimes also the employees of the firm.

This section discusses how the productivity level and growth rate of SOEs will be affected by the discussed reforms. Consider a principal-agent relationship between the government and the manager (and between a manager and his employees). In what follows I shall argue that the decentralized reforms increase the payoff of effort and learning of managers and SOE employees in comparison with in the centralized status quo, therefore affect the productivity level and growth rate. The underlying premise is summarized in lemma 1.

Lemma 1. (1) When a reform raises the reward for efforts of either the manager or the employees, the firm-level efforts increase; as a result, the productivity level shifts up. (2) When a reform raises the reward for skills (therefore learning activity) of either the manager or his representative employee, the firm-level human capital increases; as a consequence, the productivity growth of the firm increases.

Lemma 1 can be easily justified by a commonly-used production function where the value added is increasing in firm-level skills and efforts besides conventional factors like capital and labor (Jensen and Meckling, 1979; Ehrlich et al., 1994). Lemma 1 is sufficient to allow us consider how each of the reforms will affect productivity.

Marginal Profit Retention Rate. When the rate increases, the employees and managers envision a higher payoff for their efforts, which induces them to work harder. However, since the government re-adjusts the rate on an annual basis, there is no guarantee that the manager or employees can capture higher future returns for learning. So a higher marginal retention rate at period t raises the payoff of efforts, but not necessarily the payoff of learning; by lemma 1, the productivity level increases but not necessarily its growth rate.

Hypothesis 1. A higher marginal retention rate will lead to a higher productivity level but not necessarily a higher growth rate.

The Decentralization of Wage Controls. It involves two reforms: a firm-level pay sensitivity (as a part of CRS specifications), and the managerial wage discretion. Both

should raise the payoffs of efforts and of skills of employees. However, the two have a few important differences.

Though the incentive effects of firm-level pay sensitivity might be hindered by the free-riding problem (i.e., all employees benefit from the increased effort of an individual employee), "peer monitoring" partly restores the positive incentives associated with this aggregate pay sensitivity. In team interactions, low effort input of a member reduces wage incomes of other members since it is hard for the manager to distinguish each member's productivity; presumably, however, a member's effort that is unobservable to the manager can be observed by other members. As a result of the negative externality of shirking of members, all have the incentive to monitor others. So the firm-level pay sensitivity could be effective in raising efforts of employees, and, therefore, the productivity *level*. But it is unlikely to encourage employees to improve their skills and thus raise the growth rate of the firm. The most important reason is that a team member has little incentive to improve his skills: without labor market competition and without the possibility of being fired, personal payoffs are largely insensitive to skill acquisition. In addition, it is much more difficult to monitor other members in improving skills: learning efficiency is highly heterogeneous; thus the time spent on learning is a poor proxy of learning.

In contrast, the managerial wage discretion is much more effective in raising the productivity growth rate. This discretion allows the manager to reward an individual based on his productivity, and, therefore, effectively rewards both his efforts and his skills. Note that without the presence of a negative externality the managerial wage discretion involves no peer monitoring.

Hypothesis 2. The increase of firm-level pay sensitivity will raise the productivity level but is less effective in spurring the growth rate; in contrast, the delegation of managerial wage discretion will raise both the productivity level and the grow rate.

The decentralization of production decisions. When production decision rights shift from planning bureaus to managers, the quality of decision making changes, because managers have better knowledge of the technology and demand, and stronger incentives than the bureaucrats. Managers have a larger stake in firm outcomes than bureaucrats: bureaucrats' economic well-being is largely independent of how an enterprise fares, while the manager has a direct stake in the firm's outcomes--managers in poorly-performing firms were more likely to be replaced (Xu, 1996), and CEO pay-sensitivity was significantly related to its firm performance.[14] As a consequence, as the payoff to managerial efforts and skills go up, we expect a higher productivity level and growth rate.

Due to better incentives and proximity to the firm, managers have better knowledge about the technology, market demand, and personnel. When production decisions are decentralized, therefore, they will reflect the higher quality of decision making by the managers.

Hypothesis 3. When the government delegates production decision rights to managers, payoffs to efforts and skills increase, which causes both the productivity level and its growth rate to increase; better skills and the information advantage of managers over bureaucrats are at the core of improvements stemming from production decentralization.

Appointing new managers. His predecessor's firing should signal to the new manager a more credible threat of losing his position if he does a poor job. Since losing the management job incurs a certain loss of income and reputation in the managerial labor market, we expect the new manager to have incentives to work harder and invest more time in improving skills than do incumbent managers. He may also want to invest in skills because the government evaluates a manager based on observations of outcomes of many years, a time frame allowing ample room for the skill improvement to be reflected

[14]In our sample, the elasticity of CEO pay to average value added is 0.14.

in outcome improvements. Though the firm's growth rate may eventually improve due to better learning incentives, the new manager may not on average improve productivity level in the year he takes over the post: he will likely spend a significant amount of time of his first year to learn about firm-specific aspects about the job.

Hypothesis 4. Compared to a firm with an incumbent manager, ceteris paribus, a firm under a new manager will have a higher productivity growth rate; it will not necessarily have a productivity level boost due to adjustment costs.

The adoption of Contract Responsibility System. As noted, the CRS includes firm-level pay sensitivity and additional contract specifications. Having discussed the effects of firm-level pay sensitivity, here I shall only discuss how the additional contract specifications will affect productivity; for convenience, when I refer to CRS I mean the CRS specifications except the pay sensitivity part.

A CRS contract, falling into the category of performance contract, cannot improve productivity universally. For example, a performance contract will not work if it does not reduce information advantage of managers, if it does not improve the firm's incentives, and if it is not credible (World Bank, 1995). A CRS contract is typically assigned by the government without using competitive methods; as a result, its information disadvantage relative to managers is not reduced. The manager's information advantage, in turns, allows him to manipulate the performance targets so that they are easy to reach. Worse yet, CRS does not offer firms a systematical "carrot" (besides firm-level pay sensitivity), nor a "stick" -- there was no bankruptcy for SOEs in the 1980s. The performance targets tend to be numerous with respect to profit, capital maintenance, labor, and product innovations. When the manager faces many constraints regarding inputs and pursues multiple output targets, he is more likely to operate as if under a state plan than like an independent commercial firm, which single-mindedly pursues profits.

Besides these static aspects that limit the effectiveness of CRS, the lack of long-term commitment from both the government and the firm further renders CRS contracts ineffective in improving growth. A CRS contract usually lasts for three to five years, not long enough to internalize long-term investment. The government, moreover, used the CRS as an experiment, not a permanent policy instrument. Finally, SOEs have a tendency to sacrifice their potential long-term benefits for myopic gains: (a) Firm-level pay sensitivity rewards current profits, which further reduces incentives to invest, and (b) Xu (1996) found that better firms were given lower base amounts of transfers including less investment subsidies. This may produce "ratchet effects", that is, SOEs under CRS may mimic inefficiency by not working hard so that they get easy performance targets.

Hypothesis 5. Except the effects of firm-level pay sensitivity, the adoption of CRS will, on average, improve neither productivity level nor the growth rate. The adoption of CRS may affect growth rate negatively.

IV. EMPIRICAL IMPLEMENTATION

All variables used are constructed from *A Survey of State Enterprises*: 1980-1989. Some variables have many missing observations, and each of them has a different set of missing observations. In the empirical analysis, we delete observations where: (1) the dependent variable is missing; (2) capital intensity, the key conventional explanatory variable, is missing; (3) and some key variables are unreasonable outliers.[15] The sample, now an unbalanced panel, consists of *716* firms and a total of *6712* Observations. To avoid losing too much of the sample and to make full use of the information in the data, we impute the value of missing observations of a generic variable x_{it} by giving them the

[15]We consider an observation to be an outlier when its value seems unreasonable, for example, when the marginal retention rate is negative or larger than 1.

average values of their observed (industry, year, province, governance status) cell.[16] In addition, we create a dummy variable m_x_{it} whose value is *1* if x_{it} is missing for firm *i* and year *t*. Then, the coefficient of m_x_{it} measures the differences in average productivity between firm-years with missing x_{it} and those without. The incidence of missing observations for each variable is contained in table A.1 of the appendix. The definitions of the variables are contained in table 2.

Here we estimate how the decentralized reforms affected both the *level* and *growth rate* of productivity, and we conduct growth-accounting to explore the relative importance of each reform behind the productivity improvement of state enterprises.

Empirical Production Function

To estimate how the decentralized reforms affected productivity of state enterprises, we estimate a Cobb-Douglas-typed "institutionalized production function"[17]:

$$\begin{aligned}\ln(\text{avg. value added}) = {} & b_0 + \sum_j \text{reform}_j[b_{1j} + b_{2j}(\text{years since reform}_j \text{ in effect})] \\ & + b_3\ln(k) + b_4\ln(L) + \sum_k b_{5k}(\text{share of job}_k) + b_6(\text{input price index}) \\ & + \sum_l b_{7l}(\text{time - invariant dummy}_l) + \sum_t b_{8t}(\text{year - t dummy}) + u_{it}\end{aligned}$$

where job_k can be the share of engineers, of management personnel, and of "other employees." Firm-specific dummy variables consist of dummies related to a firm's industry affiliation, governance status (by central, provincial, prefecture, and county government), and province. u_{it} is the unobservable. Note that some reforms are not assumed to affect growth rate hence some b_{2j}'s are 0.

---

[16]See Greene (1990), p288-289 for the discussion of how to deal with missing observations.
[17]See Coase (1992), Jensen and Meckling (1979), McMillan et al (1989) for justification of the "institutionalized production function."

Table 2. The Definitions of Some Variables

Average value added	Total value added of a firm divided by the total number of employees, deflated by the price index of the firm's output price.
MARGINAL_RATE	The marginal profit retention rate at year *t*, set before the year begins.
AUTONOMY	A dummy variable whose value is 1 in all years after the government delegates production decision rights to the manager of a firm in several areas
AUTONOMY_ EVENTUALLY	A dummy variable whose value is 1 if a firm eventually had *autonomy* within the period, and did not in the year *t*, 0 otherwise.
S_PLANQUAN	The share of a firm's output under the government's mandatory plan. Another measure of the extent of decentralization of production decisions.
W_DISCRETION	A dummy variable that is 1 when the manager of a firm had managerial wage discretion.
W_DISCRETION_ EVENTUALLY	A dummy variable that is 1 when the firm did not have managerial wage discretion in year *t* but eventually did, 0 otherwise.
CRS	A dummy variable that is *1* when the firm was under *Contract Responsibility System* in the considered year
CRS_EVENTUALLY	A dummy variable that is 1 when the firm did not adopt CRS at the year *t* but eventually did, 0 otherwise.
W_ELASTICITY	*ex ante* wage elasticity with respect to profit at the firm level, fixed after the adoption of CRS.
New management variables	four dummy variables whose values are 1's if a firm had a new manager--any manager appointed after 1980--at the year and was governed by central, provincial, prefecture, and county government, respectively.
Labor quantity (L) and its quality	Labor quantity is measured by the number of employees of the firm, and its quality by the share of employees as engineers, the share as management personnel, and the share as "other employees"[18]. Since all firms in the sample are in manufacturing, the share of engineers should be a good proxy for human capital level.
FIRM AGE	Used to measure the learning-by-doing experience of a firm (Bahk and Gort 1994).
k	The average of fixed capital stock in the beginning of this and the next year, deflated by firm-specific output prices.
INPUT_PRICE	An index that measures the average input price of a firm relative to market input prices (which were normalized to *1*). The lower this index, the more subsidized the firm's input was, and the higher should be its average value added.

[18] *Engineers* is an abbreviation of *engineering and technical personnel* which refers to those employees with technological knowledge. We assume they are skilled workers. In this data set, they have higher schooling levels than other categories of employees. *Management personnel* is a synonym for *bureaucrats at the firm*, who include officials of communist parties, unions (not with real power in any sense--they may occasionally hold some entertainment or sports event), and managers and clerks of different departments of the firm, etc. *Other employees* are those that are not involved in regular work throughout the entire year due to absenteeism, illness, and leave, among other reasons.

Identification Issues

One immediate complication is that since socialist firms do not face complete markets, the inter-firm productivity difference measured by average value added may merely reflect differences in output and input prices rather than real productivity. However, Chinese SOEs did face active markets for both inputs and products, as discussed earlier. In addition, industry, governance, year and firm dummies should be able to filter out most of the price measurement error, because the deviation of state-imposed price from market price was likely industry-, governance-, year-, and firm-specific.

Another objection might be the inconsistency caused by omitting variables. We recognize that some important characteristics of the firms are not specified in the production function but should be; to the extent we can, we include proxies for them in the regression. One such characteristic is labor quality. Chinese state enterprises had an extremely low turnover rate due to their *de facto* no firing constraint, which induced high labor quality correlation over time. The inclusion of firm dummies should mitigate the problem. Another characteristic is the extent of market power or scale economies, the effects of which on productivity will be correlated over time; the inclusion of firm and industry dummies should alleviate the problem. Another important omitted characteristic may be implicit subsidies a firm received--including the firm-specific differential of planned price--for which we have no measurement. The more subsidy a firm received, the higher value added the firm should achieve *ceteris paribus*. We account for the omitted variable problem for the implicit subsidy as we did with price measurement error: we include industry-, governance-, firm-, and year-specific dummy variables, which should

mitigate the omitting variable problem associated with labor quality and scale economies. The dummy variables should filter out most of the systematic component of the subsidy because: (a) the subsidy levels across industries differ systematically; (b) firms governed by lower-levels of government enjoy lower levels of subsidy, because local governments tended to impose harder budget constraints on firms. (c) The government adjusted subsidy levels several times over the decade; the macro effects on subsidy should, therefore, be filtered out by the year dummies, and (d) to a large extent a high subsidy-recipient would remain so throughout the decade, especially after netting out the annual trend--firm dummies should, therefore, filter out the average subsidy the firm received.

The most thorny objection is that the estimates of reform effects could be inconsistent because the reform variables are endogenous: they perhaps are the results of maximizing choices of the government or firms (simultaneity or selection bias). For instance, CRS status could be a result of self-selection by a firm: the firm accepts CRS only if it is better off with the adoption.[19] Also the government might bail out firms in financial trouble by granting them favorable institutional arrangements.

One way to deal with the simultaneity bias problem of reform variables is the control function method.[20] Specifically, decompose u_{it} into a firm-specific effect ϕ_i and time-varying white noise η_{it} such that $u_{it} = \phi_i + \eta_{it}$. Suppose the simultaneity bias arises because ϕ_i is correlated with reforms. If we can find a function of observed variables to substitute for the unobserved fixed effects, ϕ_i, the control function will capture the

[19]As noted by Tidrick et al. (1987), the Chinese state enterprise sector was a "bargained economy": for example, target performances and the tax rates of the firm are bargainable.
[20]See Heckman and Hotz (1986) for an application of the control function method.

component of u_{it} that is correlated with reforms variables. Xu (1996) found that the decentralized reforms were selectively assigned across firms and time. For instance, firms with better previous performance tended to adopt CRS, while less fortunate firms tended to receive a higher amount of transfer. It therefore appears that the sample of firms that eventually underwent reform j is a sample distinct from those that did not have reform j eventually, and thus we assume a reasonable control function for the unobservable is linear in the "eventually" variables:

Z_i={AUTONOMY_EVENTUALLY, CRS_EVENTUALLY,

W_DISCRETION_EVENTUALLY} (Definitions in table 2).

This choice of control function appears to make sense. We estimate a production function with and without Z_i, and examine which specification fits the data better. The results without Z_i are presented in column (2) and column (5) of table 3, those without are not reported. We reject decisively the null hypothesis that the coefficients of selection bias controls are all zero. Therefore Z_i should be included in the production functions to control for the firm-specific heterogeneity. We also attempted to control for sample control dummies related to management changes, but we decide to not include them because they offered little explanatory power-- none were significant, a result not surprising, perhaps, since the vast majority of the firms had changed their managers over the decade.

Effects of Decentralized Reforms: Empirical Estimates

We estimate a series of production function to study how the decentralized reforms affected average value added. The results are presented in table 3. In the level

Table 3. The Effects of Decentralized Reforms for Chinese SOEs (1980--89)

Dependent Variable=ln(Value Added Per Employee)

Variables	The Level Model			The Growth Model		
	(2) OLS[a]	(3) FE[b]	(4) RE	(5) OLS	(6) FE	(7) RE
ln(k)	0.404***	0.303***	0.319***	0.404***	0.305***	0.321***
	(0.014)	(0.018)	(0.017)	(0.014)	(0.018)	(0.017)
ln(number of employees)	0.012	-0.056	0.027	0.011	-0.089**	0.019
	(0.012)	(0.045)	(0.023)	(0.012)	(0.045)	(0.023)
Share of management personnel	-0.533***	-0.240	-0.308	-0.555***	-0.237	-0.309
	(0.203)	(0.254)	(0.232)	(0.203)	(0.253)	(0.231)
Share of engineers	1.588***	-0.141	0.484	1.620***	-0.100	0.524
	(0.269)	(0.362)	(0.323)	(0.268)	(0.361)	(0.323)
Share of "other workers"	-0.140	-0.359	-0.281	-0.126	-0.274	-0.210
	(0.147)	(0.242)	(0.205)	(0.147)	(0.241)	(0.205)
Firm age	0.018***	0.049***	0.023***	0.018***	0.043***	0.022***
	(0.001)	(0.013)	(0.003)	(0.001)	(0.013)	(0.003)
(Firm age)^2	0.000***	-0.001***	0.000***	0.000***	-0.001***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
INPUT_PRICE: the average input price relative to the market input price	-0.192**	-0.079	-0.071	-0.199**	-0.092	-0.085
	(0.090)	(0.077)	(0.076)	(0.090)	(0.077)	(0.076)
Marginal profit retention rate	0.114**	0.109**	0.118**	0.112**	0.109**	0.117**
	(0.047)	(0.055)	(0.051)	(0.047)	(0.055)	(0.051)
Dummy: AUTONOMY_EVENTUALLY			-0.088*			-0.114**
			(0.048)			(0.048)
Dummy: autonomy	0.045**	0.101***	0.110***	0.019	0.060**	0.067***
	(0.022)	(0.023)	(0.023)	(0.032)	(0.025)	(0.025)
autonomy * year				0.009	0.029***	0.026***
				(0.007)	(0.007)	(0.006)
S_PLANQUAN	0.049	-0.154***	-0.135***	0.039	-0.167***	-0.148***
	(0.035)	(0.035)	(0.033)	(0.035)	(0.035)	(0.033)
Dummy: W_DISCRETION_EVENTUALLY			-0.021			-0.023
			(0.045)			(0.045)
Dummy: W_DISCRETION, managerial wage discretion	0.163***	0.147***	0.156***	0.077	0.076**	0.082**
	(0.030)	(0.027)	(0.027)	(0.049)	(0.036)	(0.036)
W_DISCRETION * year				0.034**	0.034***	0.035***
				(0.015)	(0.012)	(0.012)
Dummy: CRS_EVENTUALLY			0.195***			0.193***
			(0.064)			(0.065)
Dummy: CRS	0.026	-0.004	-0.001	0.029	0.018	0.027
	(0.044)	(0.035)	(0.035)	(0.053)	(0.039)	(0.040)
CRS * year				0.003	-0.022	-0.020
				(0.019)	(0.016)	(0.016)

Table 3 (Cont'd)

Variables	The Level Model			The Growth Model		
	OLS	FE	RE	OLS	FE	RE
W_ELASTICITY: Firm-level pay sensitivity	0.289***	0.155***	0.143***	0.274***	0.131***	0.118**
	(0.060)	(0.048)	(0.048)	(0.060)	(0.048)	(0.048)
Dummy (*central*_NewMan): the firm had a new manager & was governed by the *central* gov't	-0.140**	0.006	-0.011	-0.036	0.074	0.062
	(0.061)	(0.050)	(0.049)	(0.092)	(0.065)	(0.066)
*central*_NewMan * year				-0.028	-0.005	-0.013
				(0.020)	(0.015)	(0.015)
Dummy (*province*_NewMan): the firm had a new manager & was governed by a *provincial* gov't	0.134**	0.102**	0.128***	-0.023	-0.007	-0.002
	(0.059)	(0.047)	(0.047)	(0.095)	(0.066)	(0.067)
*province*_NewMan * year				0.053**	0.064***	0.063***
				(0.024)	(0.018)	(0.018)
Dummy (*prefeture*_NewMan): the firm had a new manager & was governed by a *prefecture* gov't	-0.045*	-0.032	-0.042*	-0.061*	-0.028	-0.038
	(0.025)	(0.024)	(0.023)	(0.033)	(0.025)	(0.025)
*prefecture*_NewMan * year				0.007	0.022***	0.013**
				(0.007)	(0.007)	(0.007)
Dummy (*county*_NewMan): the firm had a new manager & was governed by a *county* gov't	0.039	-0.010	0.021	-0.099	-0.111*	-0.101
	(0.057)	(0.051)	(0.049)	(0.086)	(0.063)	(0.063)
*county*_NewMan * year				0.041**	0.066***	0.061***
				(0.019)	(0.016)	(0.015)
R Square	0.330	See note c		0.332	See note c	
Sample Size	6544	6544	6544	6544	6544	6544

Source. -- Based on *A Survey of State Enterprises: 1980-1989.*

[a] In all OLS and RE estimations of this table (column 2, 4, 5, and 7), we also control the following variables: 9 year dummies, 3 provincial dummies, 9 industry dummies, 4 governance dummies (the firm governed by the central, provincial, city, county government), and the missing indicators for W_ELASTICITY, marginal retention rate, and share of output under the mandatory plan of the government.

[b] In all fixed effects estimations of this table (column 3, 6), we also control the following variables: 9 year dummies, and missing indicators for firm-level pay sensitivity, marginal retention rate, and share of output under the mandatory plan of the government.

[c] For the level model: (1) the F statistic for FE vs. OLS is 14.8 with a P value of 0.000; (2) the Breusch-Pagen test statistic for RE vs. OLS is 6224 with a P value of 0.000; (3) the Hausman (chi square) test statistic for FE vs. RE is 386.5 with a P value of 0.000. For the growth model: (1) the F statistic for FE vs. OLS is 15.01 with a P value of 0.000; (2) the Breusch-Pagen test statistic for RE vs. OLS is 6288 with a P value of 0.000; (3) the Hausman (chi square) test statistic for FE vs. RE is 271.9 with a P value of 0.000.

specification(columns 2 to 4), reforms are assumed to have *level effects only.* In the growth specification (columns 5 to 7), besides level effects the reforms are assumed to have a impact on the growth rate of the firm: we allow the grow rate of a firm to depend

on the dummies for managerial wage discretion, production autonomy, CRS participation, and new management.

Specification tests for both models indicate that the FE models fit the data best. To investigate whether the reforms affected the productivity growth rate, we test the null that the time-interacting terms in the growth model are jointly 0. This hypothesis is rejected at any reasonable significance level for the OLS, FE, and RE specifications. We conclude that the reforms did enhance the firm-specific grow rate, and that the discussion of empirical results should focus primarily on the growth model, especially its fixed effects specification.

The increase of the marginal retention rate improved productivity level. In both models, this result seem to be quite robust: a 10% increase of marginal retention rate would improve the value added per capita by roughly 1.1%. We also have evidence indicating that the marginal retention rates did not affect the growth rate: in three exploratory regressions (OLS, FE, and RE specifications) in which the average marginal retention rate was interacted with time, the interaction terms were all insignificant. These findings support hypothesis 1: a higher marginal retention rate raises the level but not the growth rate of productivity.

AUTONOMY improved both the productivity level and its growth rate, and the government seemed to delegate it selectively. By the preferred fixed effects estimate of growth model, AUTONOMY would raise the productivity level by 6%, and boost its growth rate by 2.9%. The results are also quite robust. The random effects estimates indicate that the government selectively delegated production autonomy: compared to

eventually-*un*delegated firms, the eventually-delegated firms had a 11.4% lower productivity level ex ante; once the delegation was made, however, they caught up with the eventually-*un*delegated firms by improving their productivity levels and growth rates. Another indication of the importance of production autonomy is S_PLANQUAN,[21] which was negatively and significantly related to productivity. All these findings support hypothesis 3: delegated authority over production does improve productivity and growth rates.

The decentralization of wage control rights is also found to affect both the level and growth rate of productivity, just as predicted by hypothesis 2. By FE estimates the delegation of managerial wage discretion (W_DISCRETION) improved the productivity level by 7.6%, and its growth rate by 3.4%. While impressive in magnitude, these numbers are also robust. The RE estimates suggest that W_DISCRETION was randomly delegated after controlling for the rest of the variables. We also find that firm-level pay sensitivity (W_ELASTICITY) robustly enhance the productivity level. Yet this wage control rights was not found to affect the growth rate of the productivity: in an exploratory regression, we interacted the firm-level pay sensitivity with the time since this right was implemented, and found it to be insignificant.

The adoption of CRS, often thought to be the most important reform for SOEs, did not significantly affect productivity. Note that the effects of CRS measured here are net of the firm-level pay sensitivity. We find no evidence that the adoption itself (without the firm-level wage incentives) either improved the productivity or the growth rate. Further, the firms chose to adopt CRS selectively: compared to firms eventually without CRS, the firms eventually under CRS had a 19.3% higher productivity ex ante. Though insignificant, the coefficients of the interaction term of CRS and time are negative in both

[21]The share of the firm's output under the government's mandatory plan.

FE and RE effects models, implying a negative impact of adopting CRS upon the growth rate. These findings support hypothesis 5--because the CRS was unable to reduce informational asymmetry and to commit firm and the government to meaningful performance improvement, it did little to improve productivity level or growth rates.

The appointment of new managers mainly affected the growth rate but not the level of productivity, just as suggested by hypothesis 4. Since the level of competition and the likely probability of managerial turnover differs among firms governed by different levels of government, we allow both the productivity level and the growth rate effects of appointing a new manager to differ among firms governed by the central, provincial, prefecture, and county government. Indeed, according to the estimates of the growth model, appointing new managers did not significantly affect the level for all firms except those governed by the county government, whose productivity level dropped by 11% in the year that the new manager was appointed. Appointing new managers significantly improved the growth rate of all firms except those governed by the central government: 6.3% for those governed by the provincial government, 1.3% for those governed by the prefecture government, and 6.1% for those governed by the county government. These growth rate effects are by any standard quite large. It is, perhaps, not surprising that appointing new managers for the firms governed by central government affected neither the productivity level nor its growth rate; the managerial labor market was likely to face less competition, and more replacements were likely political appointees.

Sensitivity Analysis: Outcome, Deflator, Function Form, and Samples

Alternative measures of outcomes. The productivity measure used is value added per capita. But what happens if the outcome measure chosen is gross value of output (GVO), another commonly-used outcome for socialist firms? Besides being a useful sensitivity

check, this adjustment may also shed light on how the reforms affected the traditional measure of outcomes. When we used log(per capita GVO) as the dependent variable, we also controlled for log(deflated costs of material inputs) in the right hand side of the production function, and kept other variables intact.

Table 4. Alternative Estimates of the Production Function

	Dep. Var. = GVO	Dep. Var. = Value Added
The marginal retention rate	0.049**	0.109**
AUTONOMY	0.023**	0.060**
Year* AUTONOMY	0.013***	0.029***
S_PLANQUAN	-0.079***	-0.167***
WDISCRETION	0.021	0.076**
Year*WDISCRETION	0.015***	0.034***
CRS	0.024	0.018
Year*CRS	-0.015**	-0.022
W_ELASTICITY	0.022	0.131***
Appointing new managers for firms governed by all levels of gov't	insignificant	insignificant except a significantly negative level effect for county-governed firms
Year*appointing a new manager for centrally-governed firms	0.006	-0.005
Year*appointing a new manager for provincially-governed firms	0.014*	0.064***
Year*appointing a new manager for prefecture-governed firms	0.005*	0.022***
Year*appointing a new manager for county-governed firms	-.007	0.066***

Note. ***, **, and * represent significance levels of 1%, 5%, and 10%; no asterisk implies insignificance.

The estimates of this production function show that the signs of the reforms effects are quite robust, and the magnitudes are smaller. The effects of reforms (in the

preferred FE specification of the growth model) are as follows (their counterparts from the FE specification of the growth model of table 3 are in the last column):

So the reforms in general improved per capita GVO by a smaller percentage than it improved per capita value added. This implies that the reforms in general increased material inputs costs by a smaller percentage than they did value added,[22] which, in turn, implies that the reforms seem to have increased the incentives for saving material costs.

Deflators. We have chosen the firm-specific output price index to deflate average value added and fixed capital stock. One may argue that these choices were arbitrary, especially for capital stock. To test this objection, we tried province-specific consumer price indices to deflate the average value added and capital stock. The estimates of reform effects were very similar, except that the coefficients for capital stock was dramatically reduced. The estimates about reform effects are, it appears, robust to the choices of price indices.

Functional Form. We have chosen the Cobb-Douglas production function form. To check the robustness of the estimates with respect to functional form, we re-estimate the production functions using a translog production function-- we include in the explanatory variables the second-order approximations of production functions, such as

---

[22]To see this, notice that log[GVO(r)]=log[V(r)+M(r)], where *r* represents a reform, *V* value added, and *M* material costs. Take derivative with respect to *r*, we can get:

$$\frac{d\log(GVO)}{dr} = \text{share of V in GVO} \times \frac{d\log(V)}{dr} + \text{share of M in GVO} \times \frac{d\log(M)}{dr}$$

for a positive percentage gain of per capita GVO from a reform to be smaller than the positive percentage gain of per capita value added, it is necessary that the percentage increase of M be smaller than that of per capita value added. Note that the two shares add up to 1.

(ln k)^2, *(ln L)*^{2}, *(ln k)(ln L)*, and second-order polynomials of job shares. Again, the estimates, both for the level effects and growth rate effects, are robust to changes in the form of the production function: the magnitudes and significance levels of these reform effects were very close, while the R squares increased minimally (less than one percent).

Used Samples. We have imputed several reform variables: mainly the marginal retention rate, S_PLANQUAN, and the input price index. The estimates of reform effects may, therefore, be sensitive to the imputation method. Based on sensitivity analysis on the growth specification (which, again, fits the data the best), we conclude that the reform effects are robust.

The most stringent test (in terms of the used sample) is when we delete all those observations from the sample if any of the reform variables are missing. This method eliminates 71% of the actual used sample. Using the remaining 29%, we find that the level effects of the reforms weakened somewhat. A few variables become insignificant including W_DISCRETION and W_ELASTICITY. However, robust level effects are observed for CRS, the marginal retention rate, and S_PLANQUAN. Moreover, for the reforms that have significant rate effects in the full sample regression, the estimates of the rate effects are still significant; in fact, they become a bit stronger in magnitudes. The firms governed by the central government now also significantly improved their productivity growth rates.

When we delete only those observations where the marginal retention rate is missing (40% of the used sample remains), the results are similar to the estimates above,

except that the level effects of AUTONOMY becomes insignificant, though its growth rate effects are stronger than in the full-sample estimation.

When we delete only observations where S_PLANQUAN is missing (66% of 6712 observations remains), or when we delete only observations where the input price index is missing (83% of the used sample remains), the estimates are very similar to the full-sample analysis.

The endogeneity of capital and labor. The rules governing labor and capital allocations of Chinese SOEs in the 1980s did not change much. However, to check the possibility that the reform effects are inconsistent because capital and labor allocations are correlated with the unobservable u_{it}, we include the *initial* value of capital and labor in the production function. The *initial* capital and labor should be free of contemporaneous bias caused by the correlation with the unobservable. These new estimates of reform effects are also very similar to those reported in table 3.

Growth Accounting Results Based on Model (2)

What accounted for the productivity growth of state enterprises in the 1980s? Using the conventional growth-accounting method,[23] table 5 reports the accounting results based on

[23]Growth accounting is conducted as follows. Let

$y_{it} = \alpha' X_{it} + \beta' Z_{it} + \delta' m\_Z_{it} + u_{it}$

where X_{it} is a vector of variables which do not have missing observations in the sample, Z_{it} a vector whose element has missing observations, and m_Z_{it} a vector of dummy variables whose value is *1* if the corresponding elements of Z_{it} are missing. Then over the period of *{0, ..., T}* the change in X_{it} contributes to a change in Y_{it} by $\alpha'(X_{iT} - X_{i0})$ and Z_{itk} to change in Y_{it} by

$\beta_k (Z_{iTk} - Z_{i0k}) + \delta_{k'} (m\_Z_{iTk} - m\_Z_{i0k})$

where $\delta_{k'}$ is the coefficient of m_Z_{itk}

Table 5. The Growth-Accounting Results of Chinese SOEs: 1980-89 [a]

CHANGE OF *ln*(AVERAGE VALUE ADDED)		.26
Total Contributions to change in ln(average value added) from:	**Based on Model (2)**	
Conventional Factors:		-.107
Capital-labor ratio	.006	
Number of employees	-.028	
Mix of jobs as engineers, management personnel, and production workers	-.013	
Input price index	-.072	
Change of Management:		.097
The firm was governed by the central gov't, and had new manager	.005	
Year×(a firm was governed by the central gov't, and had new manager)	-.002	
The firm was governed by the provincial gov't, and had new manager	-.001	
Year×(a firm was governed by the provincial gov't, and had new manager)	.023	
The firm was governed by the prefecture government, and had new manager	-.017	
Year×(a firm was governed by the prefecture gov't, and had new manager)	.071	
The firm was governed by the county gov't, and had new manager	-.009	
Year×(a firm was governed by the county gov't, and had new manager)	.027	
Marginal Profit Retention Rate		.008
Wage Control Rights		.109
W_DISCRETION	.026	
W_DISCRETION×(year since the manager had W_DISCRETION)	.039	
W_ELASTICITY	.044	
CRS[b]		-.033
Share of firms under Management Responsibility System (CRS)	.016	
CRS×(year since the firm adopted CRS)	-.049	
Decentralization of production decision rights:		.132
Share of output under the government's mandatory plan[c]	.006	
Share of firms whose managers had autonomy	.036	
Autonomy×(year since the manager had autonomy)	.090	
Changes of Institutional Arrangements in total:		≥ 0.109

[a] Based on FE estimates of the growth model.

[b] The effects of CRS are the total effects of adopting CRS net of the incentive effects associated with firm-level pay sensitivity, part of the CRS package. If we include the effects of pay sensitivity, then the total effects of CRS is 0.011.

[c] This variable is observed only until 1984, showing almost no change from 1984 to 89. Its small positive magnitude reflects a small change of this variable between 1984 and 1989.

FE specification of model 2.[24] The figures reported are evaluated at the means of the sample on which table 3 was based.

We find that the conventional factors did not enhance productivity overall. Capital accumulation increased average productivity only by 0.6%, and the expansion of labor force itself actually reduced labor productivity by 2.8%. The increasing share of average employees in the category of management personnel and "other employees" reduced productivity by an additional 1.3%. The increasing share of inputs purchased through the market reduced average productivity by 7.2%.

The growth accounting results clearly demonstrate that the productivity growth came mainly from decentralizing management. New management improved the average productivity by an impressive 9.9%. Furthermore, the decentralization of wage controls--W_DISCRETION and W_ELASTICITY--further contributed to a productivity increase of 10.9%. This demonstrates the importance of employee incentives, and the extent to which employees shirk when the government controls their wages. Finally, the decentralization of production decision rights--AUTONOMY, and decreased S_PLANQUAN--improved productivity by 13.2% percent.

The growth accounting results do not support the conventional wisdom about the importance of decentralizing cash flow rights of firms. The increased marginal retention rates accounted for only 0.8% of productivity growth, an effect far below those associated with decentralizing management.

[24]We have also conducted growth-accounting based on baseline model, and obtained similar results .

The government did not accomplish much in its attempts to push *CRS*: in fact, the adoption of *CRS* itself reduced the productivity by 3.3%; if we include the effects of W_ELASTICITY (a component of CRS), CRS improved the productivity by 1.1%. It is clear that CRS itself (net of the effects of firm-level pay sensitivity) did not contribute to the productivity growth in the 1980s, a result consistent with hypothesis 5.

Adding up the effects of the decentralized reforms, we find that the reforms were significant sources of the productivity increase: while productivity actually increased by 26% over this period, the decentralized reforms (including CRS, the wage controls, the marginal retention rate, S_PLANQUAN, AUTONOMY) accounted for a productivity increase of 10.9% (42% of the total productivity change). This 42% is likely to be the lower bound of the contribution from the reforms, for we do not include any of the new management effects in the category of the reform effects. It appears that part of the management turnover was a byproduct of reforms--the rate of management turnover seems to be positively correlated with CRS, AUTONOMY, W_DISCRETION and the marginal retention rate, so management turnover was, perhaps, partly a byproduct of the reforms hence its effects should be partly attributed to the reform effects. Since we do not know how much of the management turnover was due to the reforms, we stop short of dividing new management effects between reforms and conventional factors.

V. CONCLUSION

This study examines how a rich set of decentralized reforms of Chinese SOEs affected the productivity level and growth. It is a serious attempt to examine rich aspects

of the organization of the firm, and study both their static and dynamic effects. Using variations of ownership and control rights in the Chinese SOEs in the 1980s, we find:

1. It is useful to distinguish among different components of ownership and control rights.

2. It is important to examine both the dynamic and static effects of each reform. It appears that the dynamic effects are more important than the static effects in magnitude. This finding supports the idea that it is important to take into account the dynamic effects of ownership (Ehrlich et al., 1994).

3. The decentralized reforms of Chinese SOEs in the 1980s significantly raised the productivity level and growth rate. Especially effective reforms were those that spurred incentives for working hard and accumulating human capital: appointing new managers, using firm-level pay sensitivity, letting managers determine wages, and allowing managers to make production decisions. These findings imply that managers are better decision-makers than bureaucrats, that shirking prevails in centralized firms, and, therefore, that SOE reforms should strengthen managers' and employees' incentives to work hard and learn. Adopting CRS and raising profit retention rates, probably the most important reforms as viewed by the Chinese government and many scholars, did not improve productivity much; in fact, we have weak evidence that CRS might have reduced productivity growth.

4. The results appear to be robust with respect to the choices of functional form of the production function, the use of alternative deflators, the adoption of alternative samples, and whether or not we treat capital and labor as a function of decentralized reforms.

5. It is important to take into account the selectivity associated with each reform. In particular, better-performing firms appear to have adopted CRS more readily; poorly-performing SOEs were more likely to be granted managerial wage discretion.

Appendix: A.1. Incidences of Missing Observations of Used Variables

Variables	*Incidence of missing observation (%):*
Firm age	3.5
Input price index of the firm[25]	16.9
Job mix of engineers, workers, and management personnel	10.0
Marginal profit retention rate	59.6
W_ELASTICITY	2.5
S_PLANQUAN: share of output under the mandatory plan of the government[26]	33.7

Reference

Bahk, Byong-Hyong, and Michael Gort, "Decomposing Learning by Doing in New Plants," *Journal of Political Economy*, 101 (1993), 561-83.

Barberis, Nicholas, Maxim Boycko, Andrei Shleifer, and Natalia Tsukanova, "How does Privatization Work? Evidence from the Russian Shops," *The Journal of Political Economy*, 104(4), 764-90, August 1996.

Boardman, Anthony, and Aidan R. Vining, "Ownership and Performance in Competitive Environments: a Comparison of the Performance of Private, Mixed, and State-Owned Enterprises," *Journal of Law and Economics*, April 1989, 32, 1-33.

Boycko, Maxim, Andrei Shleifer, and Robert W. Vishney, "Property Rights, Soft Budget Constraints, and Privatization." Memeo., Harvard University, 1994.

Coase, Ronald, "The Institutional Structure of Production," The Nobel Prize Lecture, delivered December 9, 1991, in Stockholm, Sweden.

Demsetz, Harold , *Ownership, Control And The Firm* , New York: Basil Blackwell, 1988.

Dong, Furen, "Behavior of China's State-owned Enterprises Under the Dual System," *Caomao Jingji* (Finance and Economics), 9 (1992), 3-15.

Ehrlich, Isaac, George Gallais-Hamonno, Zhiqiang Liu, and Randall Lutter. "Productivity Growth and Firm Ownership: An Analytical and Empirical Investigation," *Journal of Political Economy*, 102 (1994), 1006-1038.

Greene, William, *Econometric Analysis*, New York: Macmillan, 1990.

Groves, Theodore, Yongmiao Hong, John McMillan, and Barry Naughton, "Autonomy and Incentives in Chinese State Enterprises," *Quarterly Journal of Economics*, 109 (1994), 181-209.

Groves, Theodore, Yongmiao Hong, John McMillan, and Barry Naughton, "China's evolving managerial labor market," forthcoming in *Journal of Political Economy*, August 1995.

Grossman, Sanford J., and Oliver D. Hart, "The cost and Benefits of Ownership: a Theory of Vertical and Lateral Integration," *Journal of Political Economy*, 90 (1986), 691-719.

[25]This is observed only after 1984. The missing incidence for this variable refers to that after 1984.
[26]This is observed only after 1983. The missing incidence for this variable refers to that after 1983.

Heckman, J., and V. Joseph Hotz, "Choosing Among Alternative Nonexperimental Methods for Estimating the Impact of Social Programs: the Case of Manpower Training," *Journal of The American Statistical Association*, 84 (1989), 862-80

Holmstrom, Bengt, and Jean Tirole, "The Theory of The Firm," in *Handbook of Industrial Organization*, vol. 1, ed. by R. Schmalensee and R.D. Willig, Elsevier Science Publishers B. V., 1989.

Lin, Justin Yifu, "Rural Reforms and Agricultural Growth in China," *American Economic Review*, 82(1), 34-51, 1992.

McMillan, John, John Whalley & Lijing Zhu, "The Impact of China's Economic Reforms on Agricultural Productivity Growth," *Journal of Political Economy* , 97 (1989), 781-807.

Jensen, Michael C. and William Meckling, " Rights and Production Functions: an Application to Labor-managed Firms and Codetermination," *Journal of Business* , 52 (1979), 469-506.

Jefferson, Gary H., and Thomas G. Rawski, "Enterprise Reform in Chinese Industry," *Economic Perspective* , 8 (1994), 47-70.

Johnson, D. Gale, "The People's Republic of China: 1978-1990," San Francisco, Calif.: ICF Press, 1990.

Lucas, Robert E., Jr., "On the Mechanics of Economic Development," *Journal of Monetary Economics*, January 1988, 22, 3-32.

Moore, John H., "Agency Costs, Technological Change, and Soviet Central Planning," *Journal of Law and Economics* , 24 (October 1981), 189-214.

Perkins, Dwight, "Completing China's Moves to the Market," *Economic Perspectives*, 8 (1994), 23-46.

Research Group for the Chinese Firm System Reform, System Reform Committee, *Management Responsibility System in Practice* , Beijing, China: The Economic Management Press, 1988.

Romer, Paul M., "Increasing Returns and Long-Run Growth," *Journal of Political Economy*, October 1986, 94, 1002-37.

Rosen, Sherwin, "Contracts and The Market for Executives," in Lars Werin and Hans Wijkander, eds., *Contract Economics*, Oxford, U.K.: Basil Blackwell, 1992.

Shleifer, Andrei, and Robert Vishny. "Politicians and Firms." *The Quarterly Journal of Economics*, 109(4), 995-1025, November 1994.

Tidrick, Gene, and Chen Ji Yuan, "China's Industrial Reforms", New York: Oxford university press, 1987.

World Bank, *Bureaucrats in Business*, New York: Oxford University Press, 1995.

Xu, Lixin Colin, "The Determinants of the Repartitioning of Property Rights of State Enterprises," memeo., University of Chicago, 1995.

Policy Research Working Paper Series

	Title	Author	Date	Contact for paper
WPS1705	The Polish Experience with Bank and Enterprise Restructuring	Fernando Montes-Negret Luca Papi	January 1997	T. Ishibe 38968
WPS1706	Monetary Policy during Transition: An Overview	Martha de Melo Cevdet Denizer	January 1997	C. Bernardo 37699
WPS1707	Trade Reorientation and Productivity Growth in Bulgarian Enterprises	Simeon Djankov Bernard Hoekman	January 1997	J. Ngaine 37947
WPS1708	Has Latin America's Post-Reform Growth Been Disappointing?	William Easterly Norman Loayza Peter Montiel	January 1997	R. Martin 31320
WPS1709	Poverty Comparisons with Noncompatible Data: Theory and Illustrations	Jean Olson Lanjouw Peter Lanjouw	January 1997	A. Ramirez 85734
WPS1710	Why Paper Mills Clean Up: Determinants of Pollution Abatement in Four Asian Countries	Raymond S. Hartman Mainul Huq	January 1997	D. Wheeler 33401
WPS1711	Issues in Comparing Poverty Trends Over Time in Côte d'Ivoire	Christine Jones Xiao Ye	January 1997	R. Martin 31320
WPS1712	Demand Elasticities in International Trade: Are They Really Low?	Arvind Panagariya Shekhar Shah Deepak Mishra	December 1996	J. Badami 80425
WPS1713	Why Did Colombian Private Savings Decline in the Early 1990s?	Alejandro López	January 1997	E. Khine 37471
WPS1714	Fiscal Federalism in Bosnia-Herzegovina: The Dayton Challenge	William Fox Christine Wallich	January 1997	Y. Jiwa 34848
WPS1715	The Evolution of Poverty and Welfare in Nigeria, 1985-92	Sudharshan Canagarajan John Ngwafon Saji Thomas	January 1997	B. Casely-Hayford 34672
WPS1716	Reforming Pensions in Zambia: An Analysis of Existing Schemes and Options for Reform	Monika Queisser Clive Bailey John Woodall	January 1997	H. Arbi 34663
WPS1717	Fiscal Federalism in Bosnia-Herzegovina: The Dayton Challenge	William Fox Christine Wallich	January 1997	Y. Jiwa 34848
WPS1718	Does Environmental Regulation Matter? Determinants of the Location of New Manufacturing Plants in India in 1994	Muthukumara Mani, Sheoli Pargal, and Mainul Huq	February 1997	E. de Castro 89121

Policy Research Working Paper Series

	Title	Author	Date	Contact for paper
WPS1719	Shifting Responsibility for Social Services As Enterprises Privatize in Belarus	David Sewell	February 1997	C. Lawrence 32216
WPS1720	The Distribution of Foreign Direct Investment in China	Harry G. Broadman Xiaolun Sun	February 1997	J. Grigsby 82423
WPS1721	EU Accession of Central and Eastern Europe: Bridging the Income Gap	Luca Barbone Juan Zalduendo	February 1997	L. Barbone 32556
WPS1722	Uncertainty, Instability, and Irreversible Investment: Theory, Evidence, and Lessons for Africa	Luis Servén	February 1997	E. Khine 37471
WPS1723	The Productivity Effects of of Decentralized Reforms: An Analysis of the Chinese Industrial Reforms	Lixin Colin Xu	February 1997	P. Sintim-Aboagye 38526